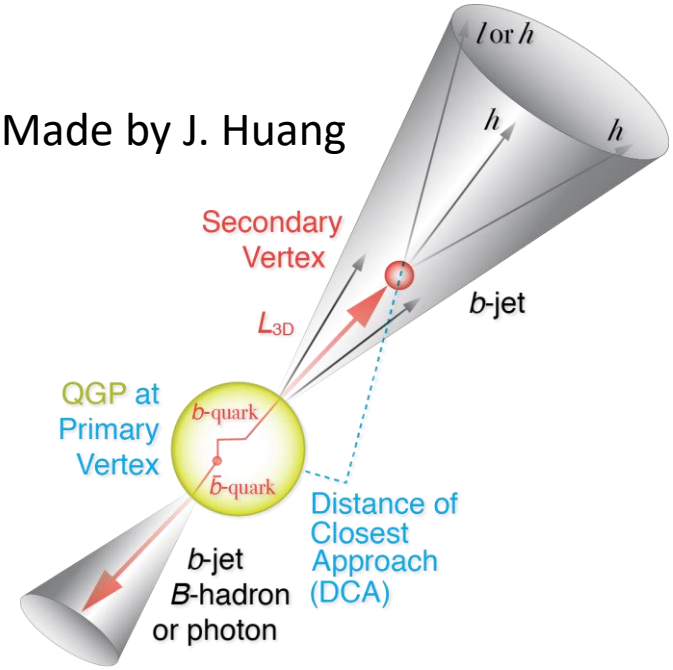
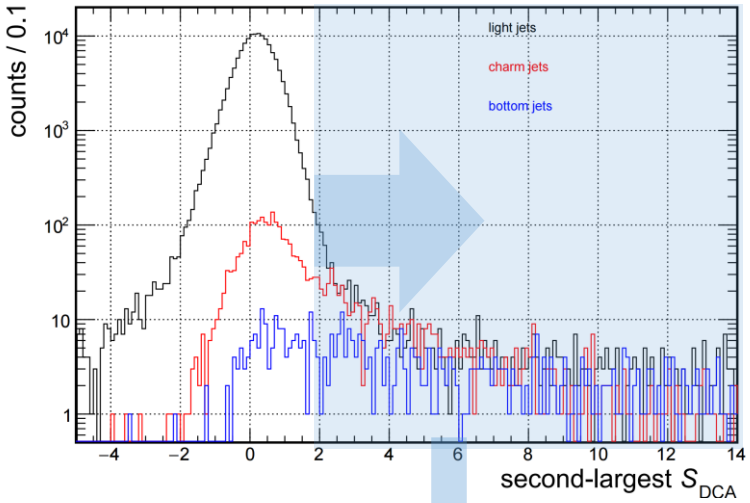
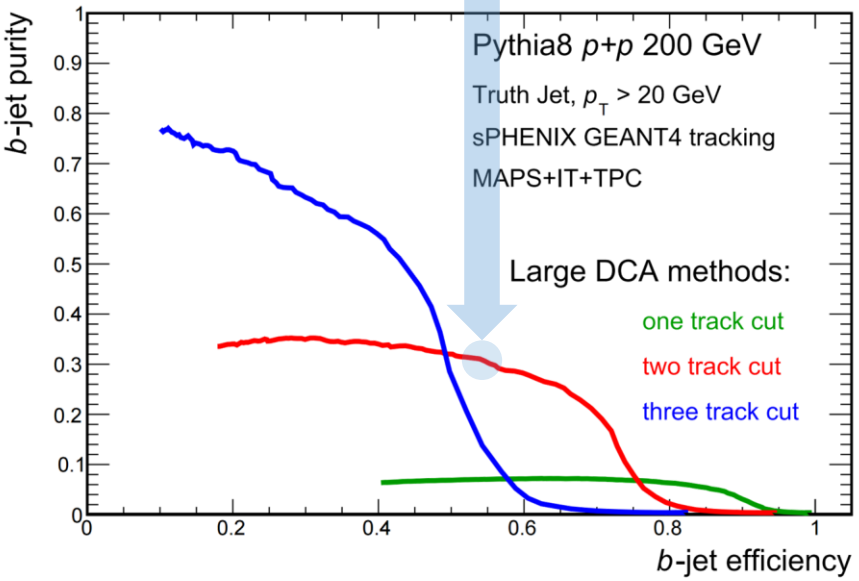
b-jet Tagging: DCA counting tagger status

Dennis Perepelitsa (UCB), Jin Huang(BNL), Haiwang Yu (NMSU)

The large DCA track counting b-jet tagging method







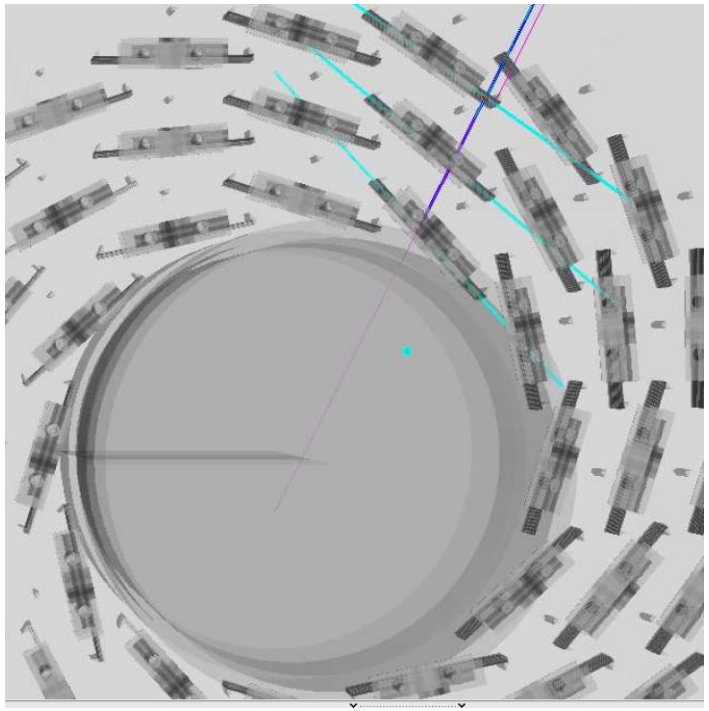
- Make minimum cut on the largest, second or third largest signed track DCA to select different portion of jets.
- This work was initialized by D. Perepelitsa. All the analysis codes was initially developed by him: https://github.com/sPHENIX-Collaboration/analysis/tree/master/HF-Jet/HighDCATrackCounting

dca2d performance with MAPS+IT+TPC tracking configuration in 2016 Sep. Tracking Review.

Progress since the Tracking Review

- dca3d development
  - some debugging to make the dca3d pull right: clustering, pattern recognition
- Hijing embedding
  - First look using the 7-layer MAPS configuration
- Kalman Filter for ladder geometry
  - Under developing with Tony and Gaku

Event display showing the norm vector used in the Kalman Filter for laddered MAPS geometry

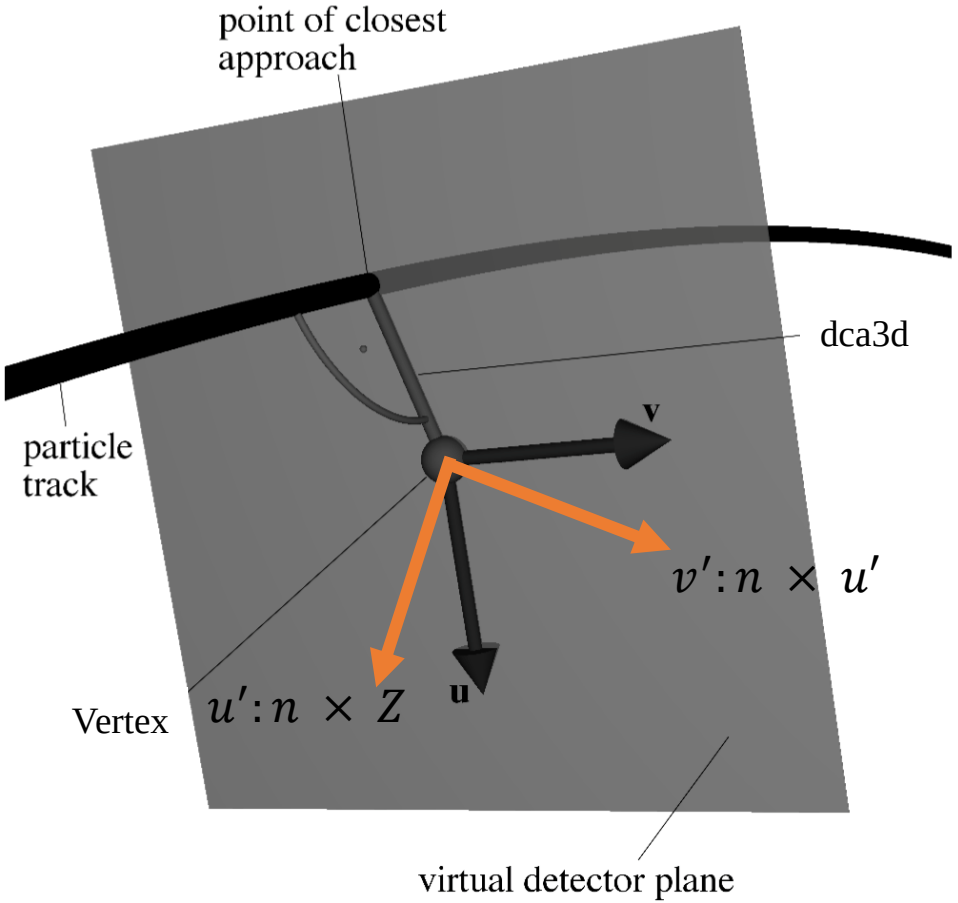


dca3d development

Evolve to 3d DCA

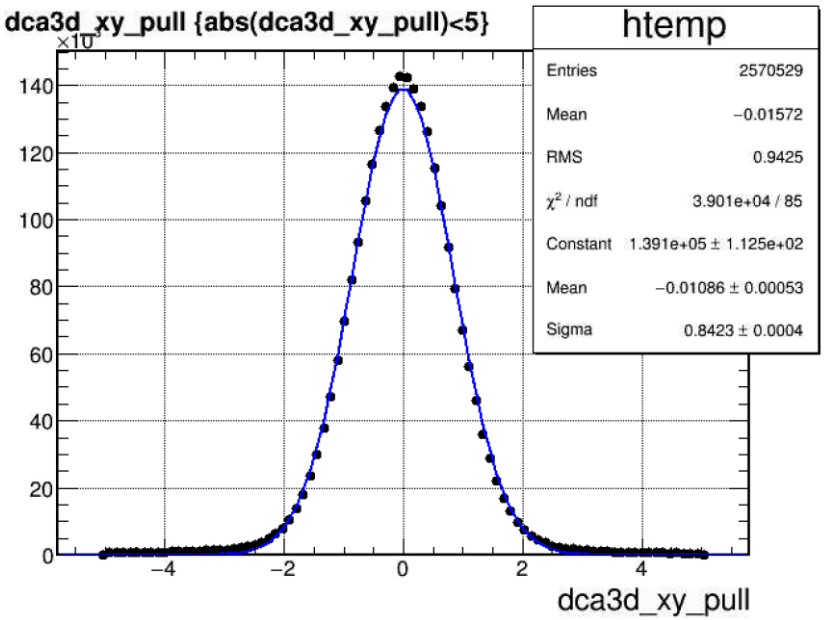
- The inner MAPS detector has very good z resolution as well. Using 20 X 20 micron for both rϕ and z resolution.

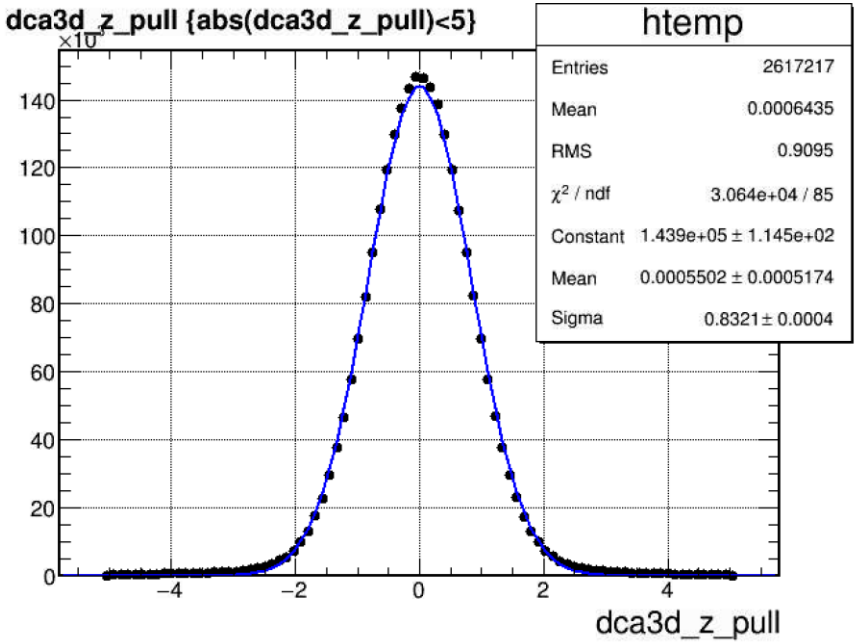
- Definition: (n: track mom. direction, Z: beam line direction)
  - dca3d_xy: $u' : n \times Z$
  - dca3d_z: $v' : n \times u'$
  - sigmalized dca3d :=
    $$\sqrt{\left(\frac{dca3d_{xy}}{\sigma_{xy}}\right)^2 + \left(\frac{dca3d_z}{\sigma_z}\right)^2}$$
  - sign of dca: sign of $mom_{jet} \cdot dir_{dca3d}$



dca3d pull distribution

- The DCA pull distribution was tested using MAPS+TPC with truth vertex setup. So may need some further tuning for MAPS+IT+TPC with RAVE vertexing.
- The pull σ's of dca3d_xy and dca3d_z are very close. So we could use the current setting to have a first look.

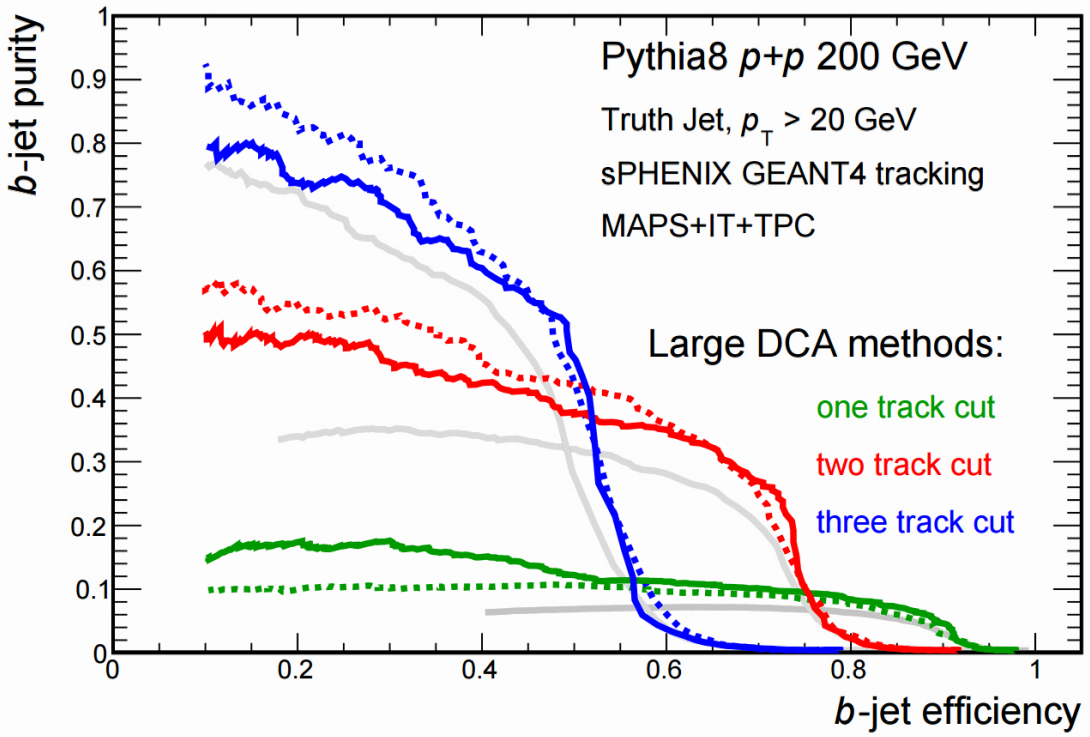




A first look at new dca3d performance

Without too much tuning, the new dca3d shows better performance than previous dca2d results.

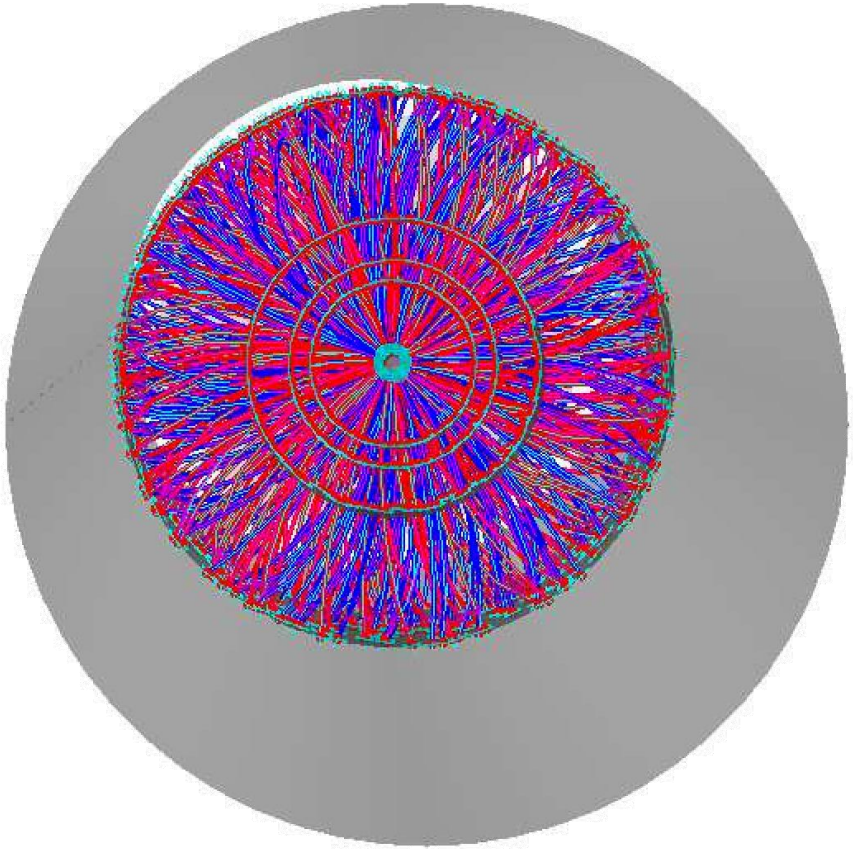
Grey: dca2d. Sep. Simulation , quality < 1
Color: GenFit dca3d, quality < 5.
dashed: original dca, solid: sigmalized dca



Hijing embedding

Pythia pp simulation embedded in central Hijing events

- Using Hijing HepMC records generated by Mike and Ron: https://wiki.bnl.gov/sPHENIX/index.php/Event_generators#Location_of_already_produced_files
- Embed Pythia8 hard QCD events
- Using Jin's Jet flavor tagger to tag the Pythia jet flavor: https://github.com/sPHENIX-Collaboration/analysis/tree/master/HF-Jet/TruthGeneration

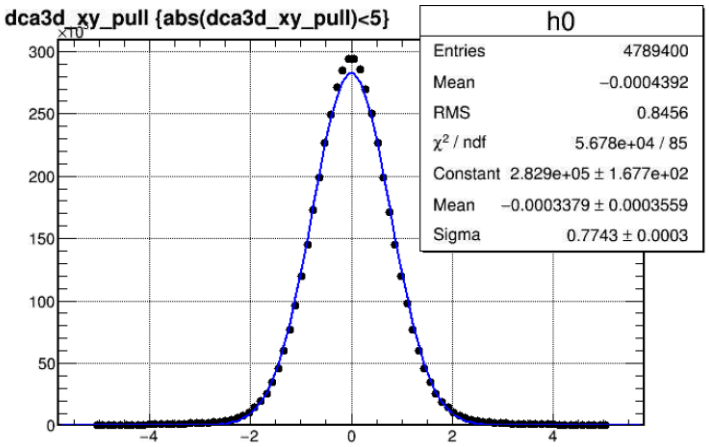


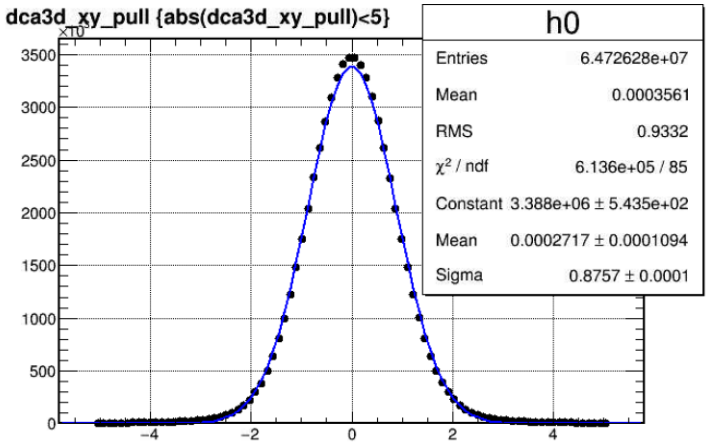
A event display showing the GenFit tracking using the 7-layer MAPS configuration.

dca3d pull in pp and Hijing simulation

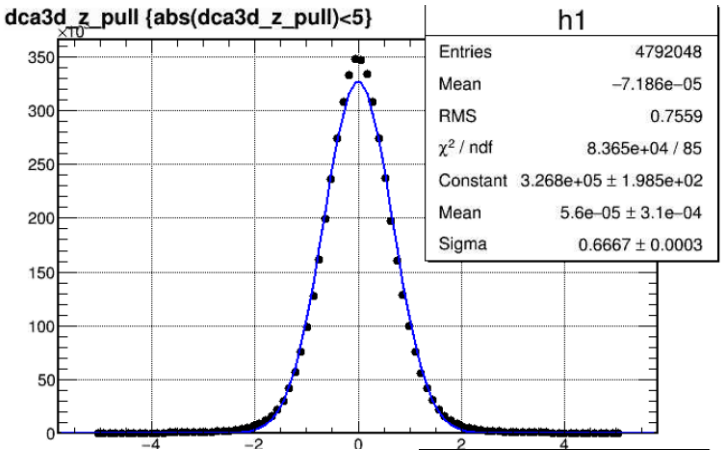
pp

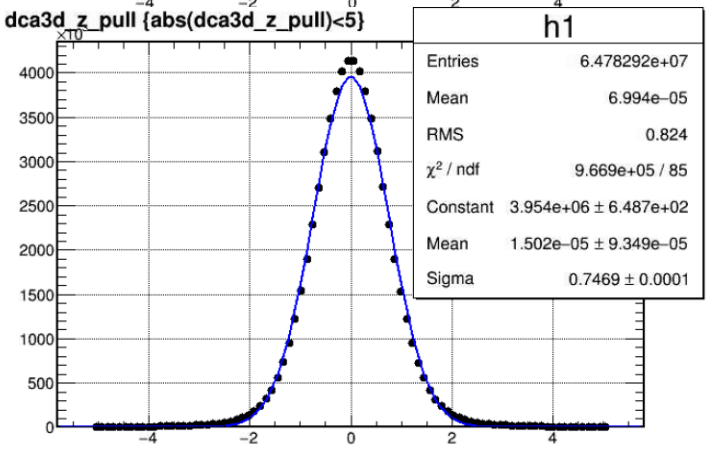
Hijing





dca3d_xy pull



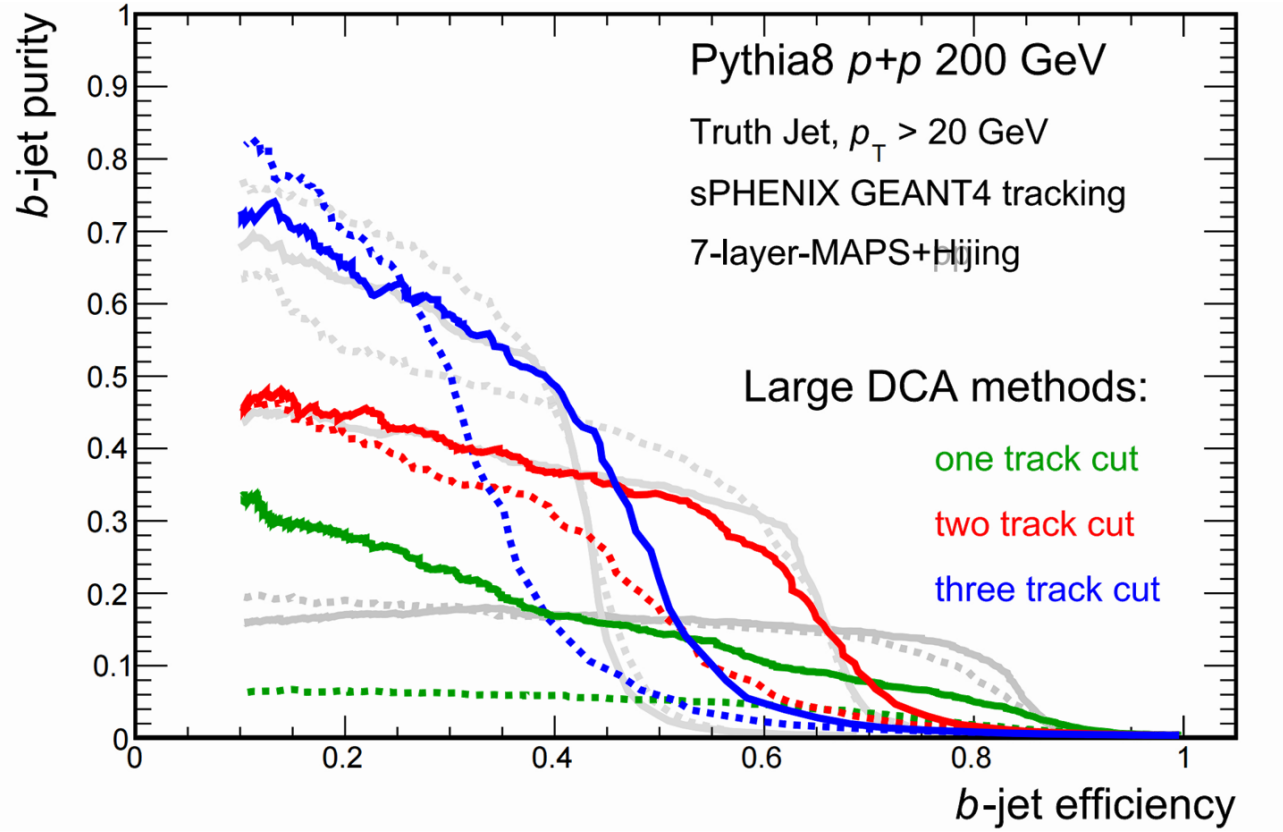


dca3d_z pull

First look at Hijing embedding results

Grey: Pythia pp
Color: Pythia pp ebedded in central Hijing events
dashed: original dca, solid: sigmalized

- With 0.5 GeV track pT cut , the Hijing results are already very close to pp results. Especially the sigmalized dca results.



Summary and Plan

- Kalman Filter for laddered geometry
- Tuning cuts to further optimize the performance
- Hijing embedding with MAPS+IT+TPC

backups

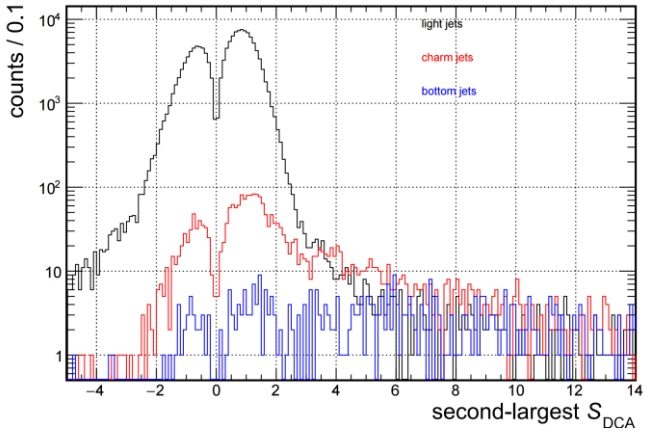
Fix the Jacobian dip?

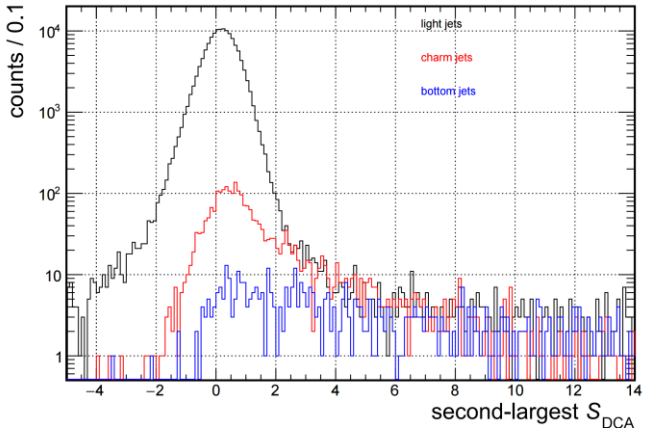
Def. 1:

$$\text{sigmalized dca3d} := \sqrt{\left(\frac{dca3d_{xy}}{\sigma_{xy}}\right)^2 + \left(\frac{dca3d_z}{\sigma_z}\right)^2}$$

Def. 2:

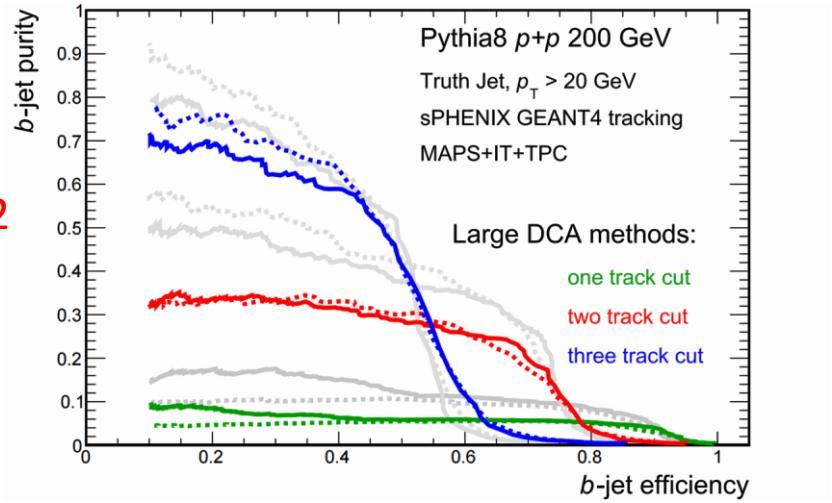
$$\text{sigmalized dca3d} := \left(\frac{dca3d_{xy}}{\sigma_{xy}}\right)^2 + \left(\frac{dca3d_z}{\sigma_z}\right)^2$$





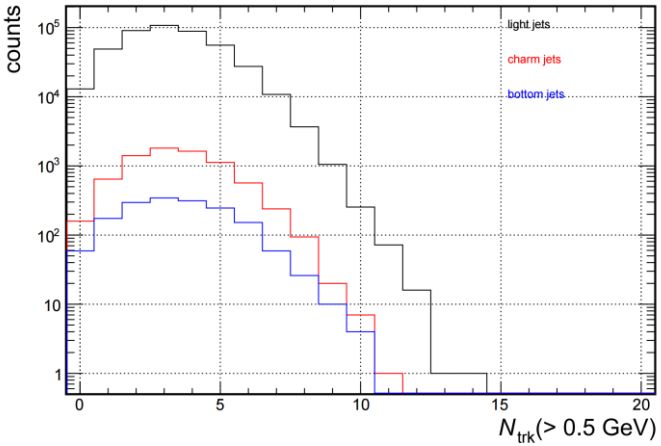
Grey: def. 1

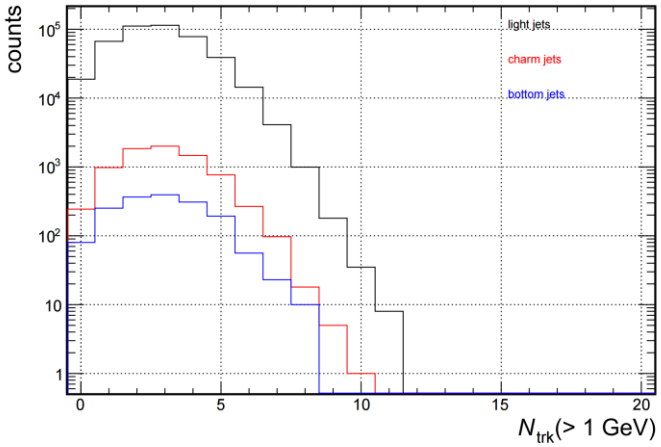
Color: def. 2



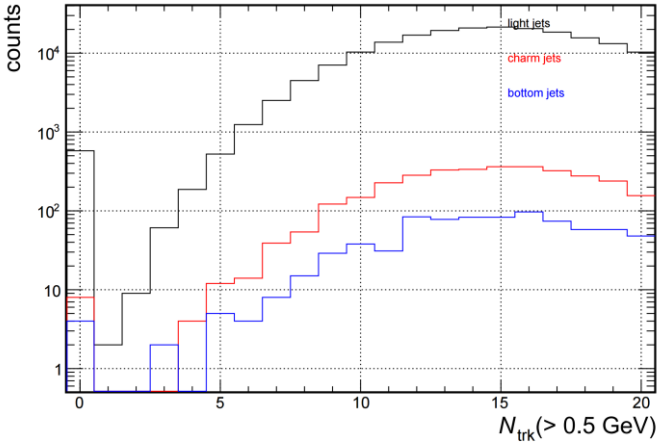
Tracks in jets

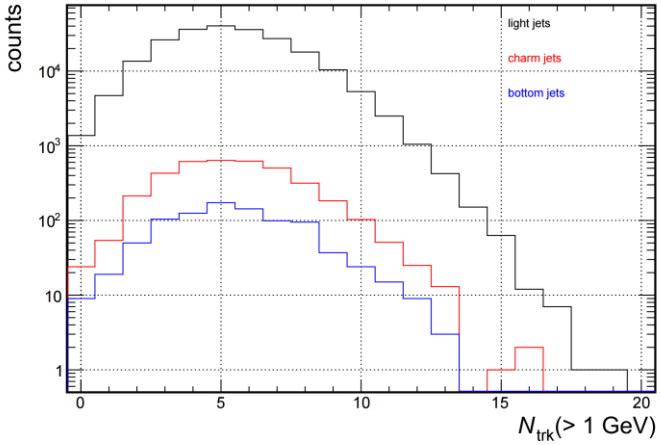
pp





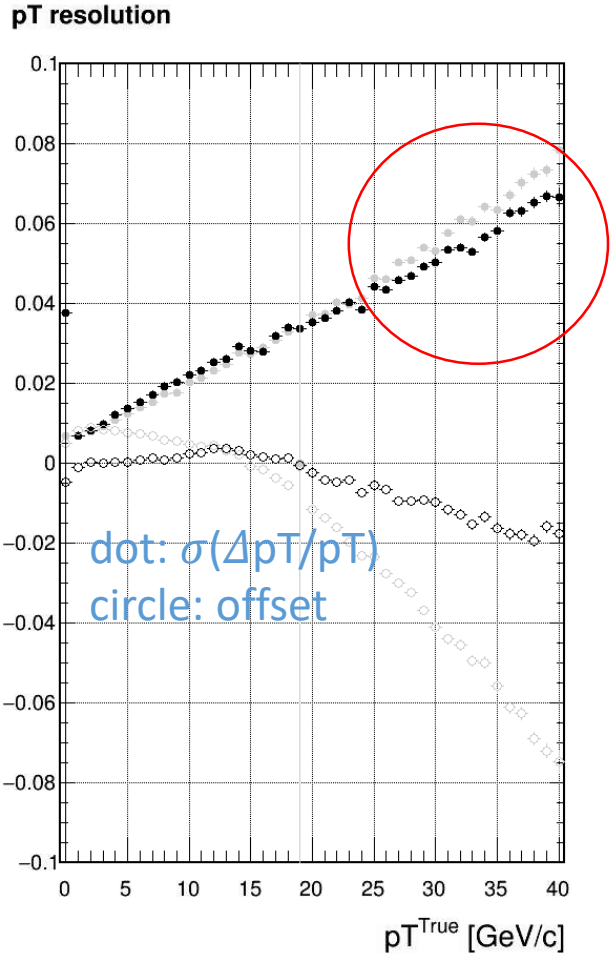
Hijing

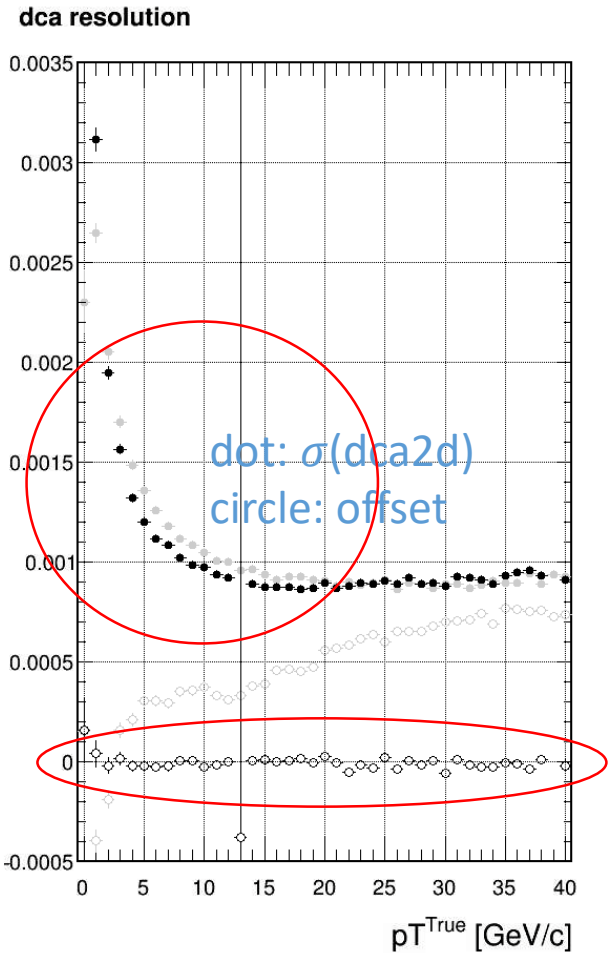


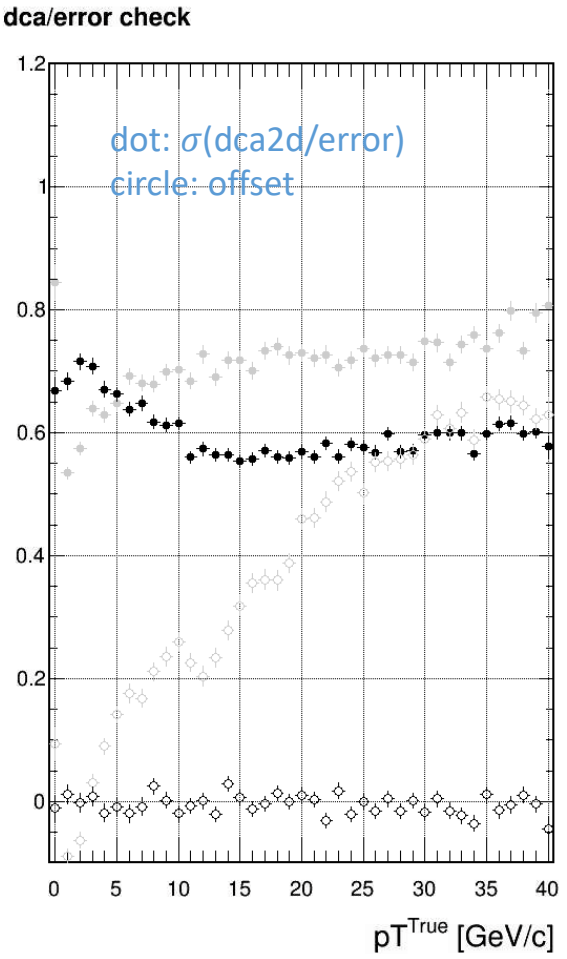


Alan (no PHG4SvtxMomentumRecal, grey) vs. GenFit (with correct norm vectors, Black)

- GenFit refitted results:
  - Better pT resolution at high pT
  - Better dca2d resolution at low pT
  - Dca2d offsets are closer to 0







First look at Hijing embedding results

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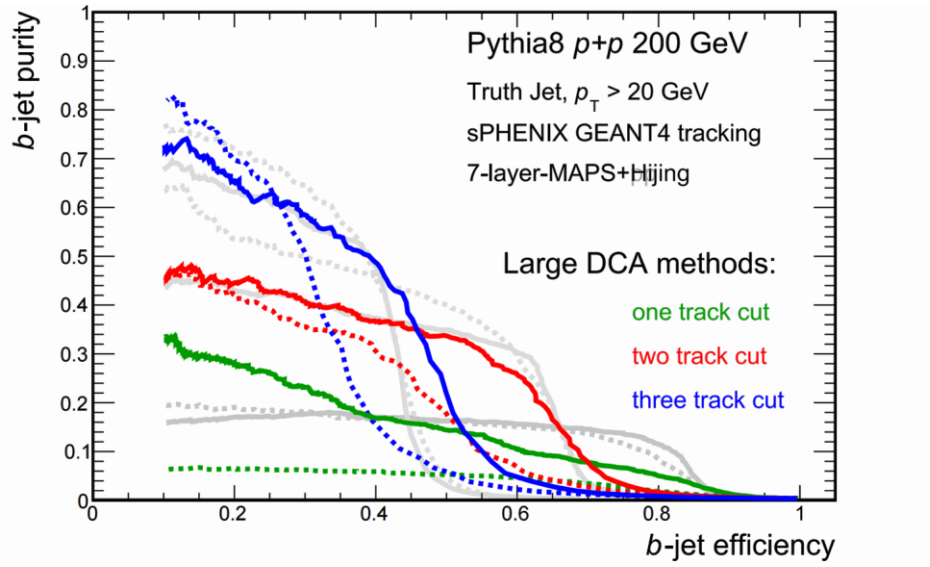
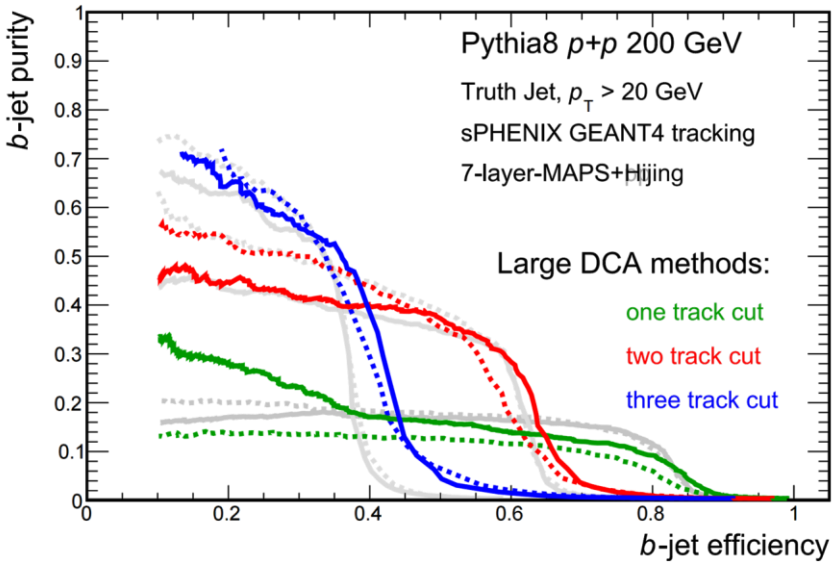
dashed: original dca, solid: sigmalized

pT > 0.5 GeV/c



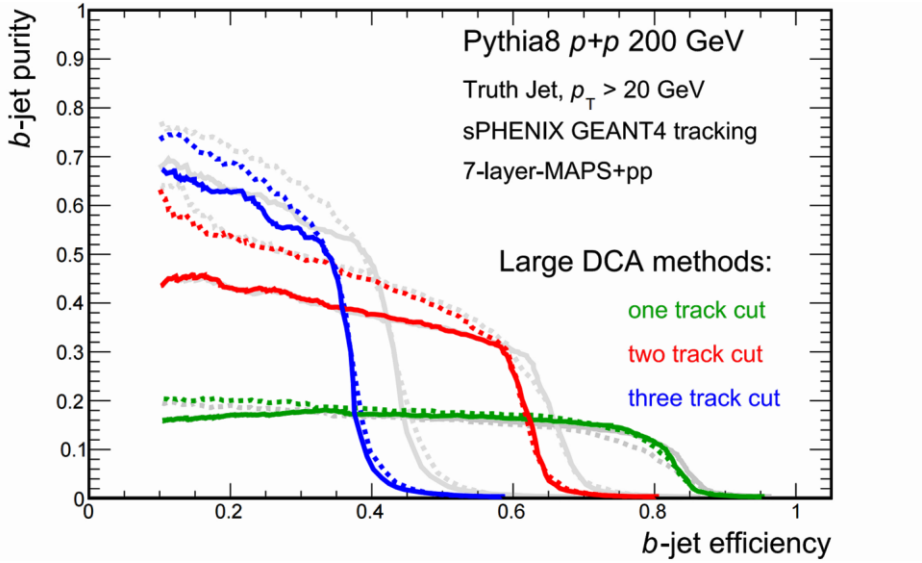
pT > 1.0 GeV/c



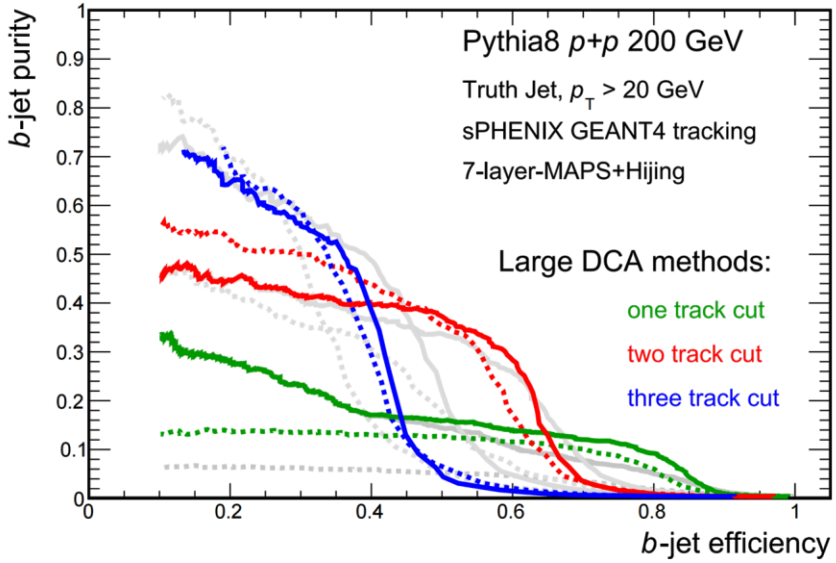
First look at Hijing embedding results

Grey: pT > 0.5 GeV/c
Color: pT > 1.0 GeV/c

pp



Hijing



30 GeV Jet Pythia8 simulation